Photogrammetric Assessment of Flexure Induced Cracking of Reinforced Concrete Beams under Service Loads

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Publication date:
2006

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2ND International RILEM Symposium,
September 11-13, 2006

BYG•DTU
Department of Civil Engineering
DTU

Outline of Today's Talk

- Motivation & Goal
- Experimental Investigation
  - Sample Geometry
  - Three-Dimensional Photogrammetry Technique
- Test Results
  - Crack Geometry
  - Crack Measurements
- Conclusions

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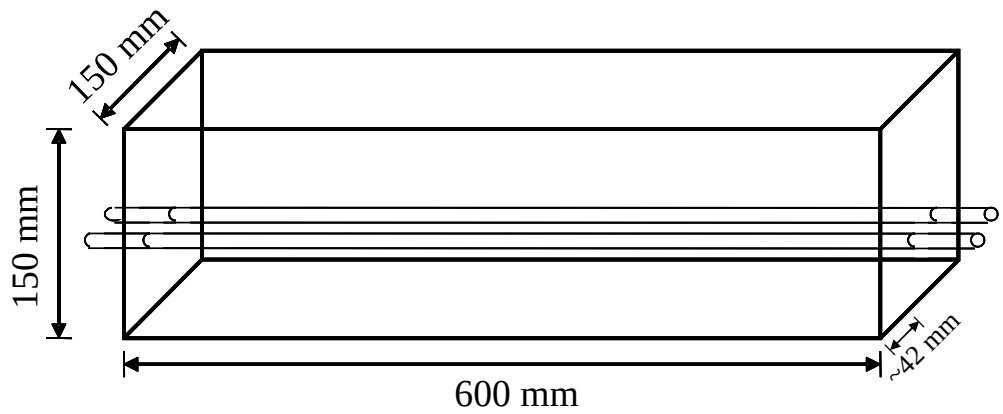
Motivation and Goal

- Motivation
  - Cracking in concrete affects ingress and corrosion (i.e. service life)
  - Cracking in reinforced concrete is complicated by slip and separation at reinforcing bar
- Goal
  - Quantify crack geometry in reinforced concrete beam during loading

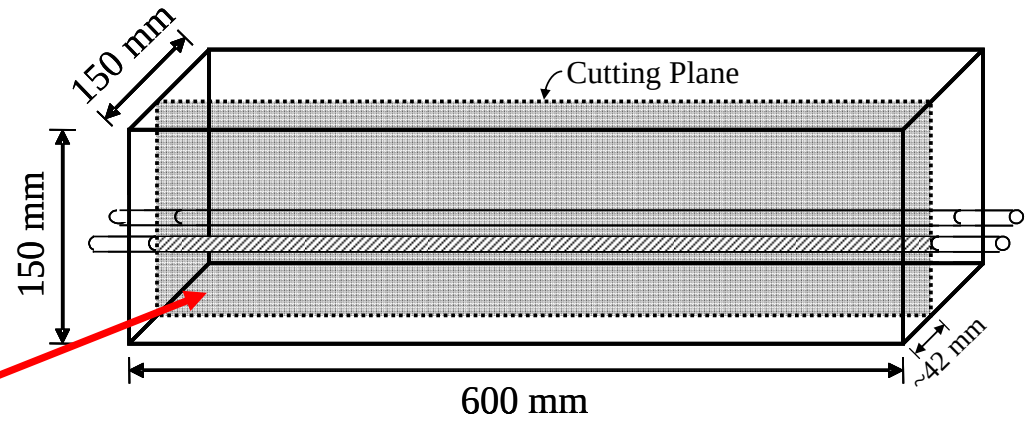
Experimental Observation of Cracks: Sample Geometry and Loading

- Reinforced beams
  (150 x 150 x 600 mm)



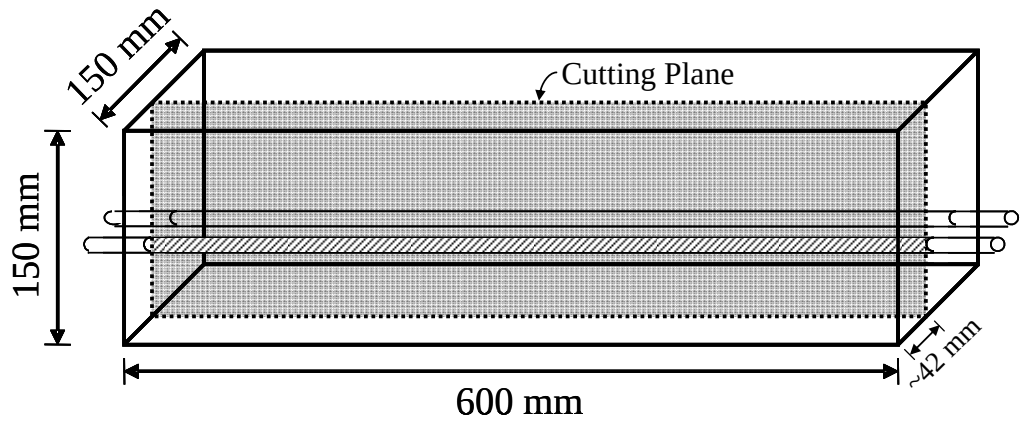
Experimental Observation of Cracks: Sample Geometry and Loading

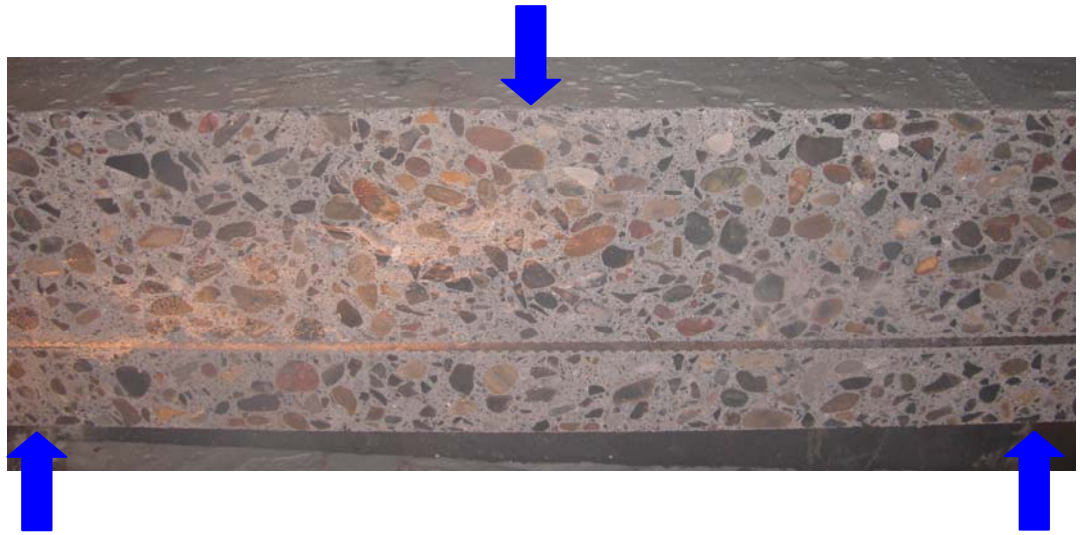
- Reinforced beams (150 x 150 x 600 mm)
- Face of concrete removed
- Exposed reinforcement and aggregate



Experimental Observation of Cracks: Sample Geometry and Loading

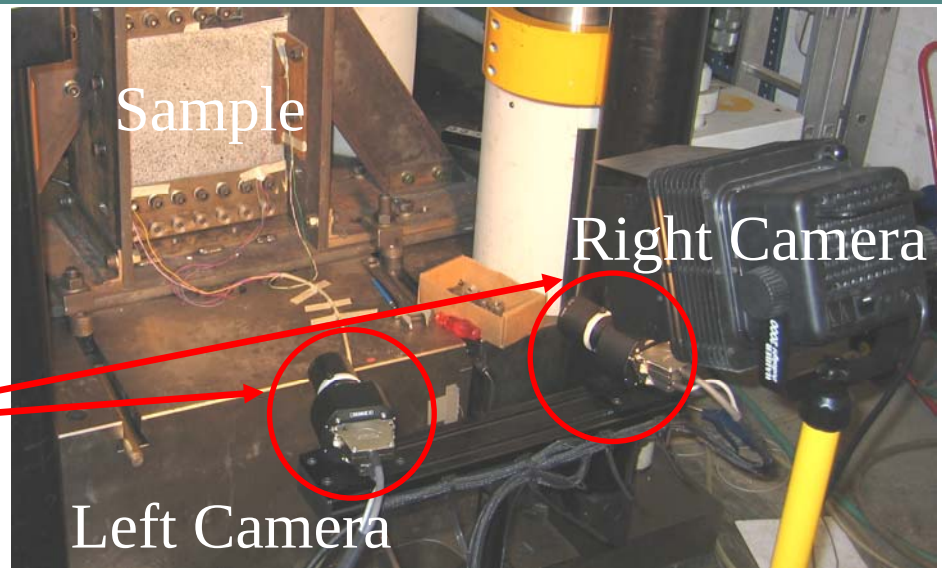
- Reinforced beams (150 x 150 x 600 mm)
- Face of concrete removed
- Exposed reinforcement and aggregate
- 3-Point bending
  - 1.0 and 1.8 times estimated cracking load (13 and 25.2 kN)
  - 35 kN

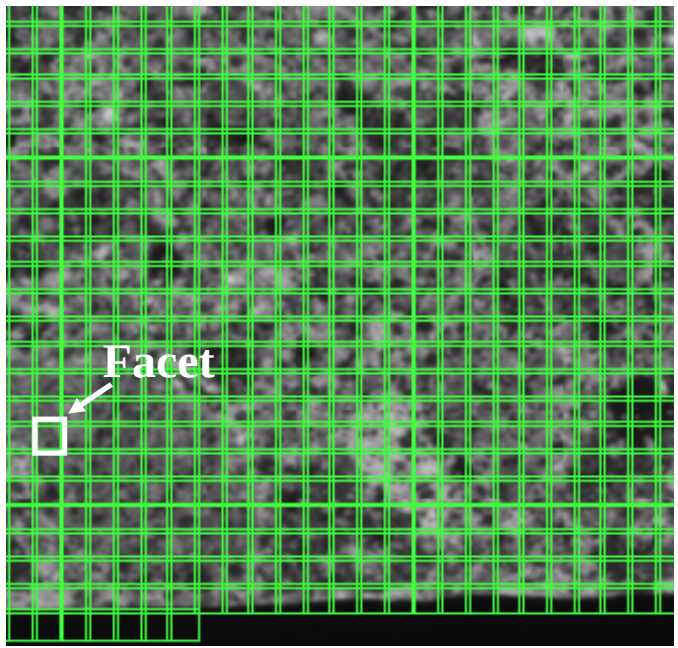




3-D Photogrammetry

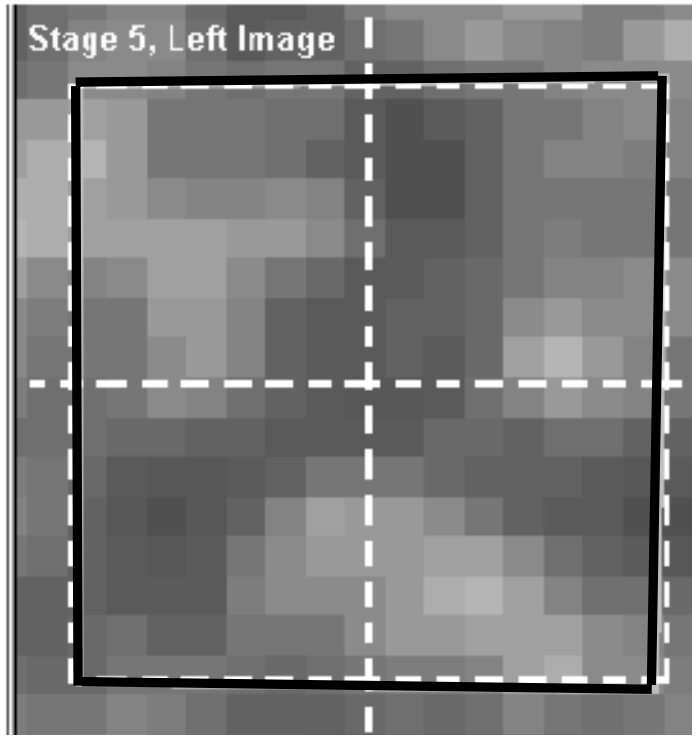
- Photogrammetry quantifies cracking during loading
- Two digital cameras placed equidistant from sample, focused on same point collect images
- Images separated into a mesh by software
  - Individual mesh box = facet

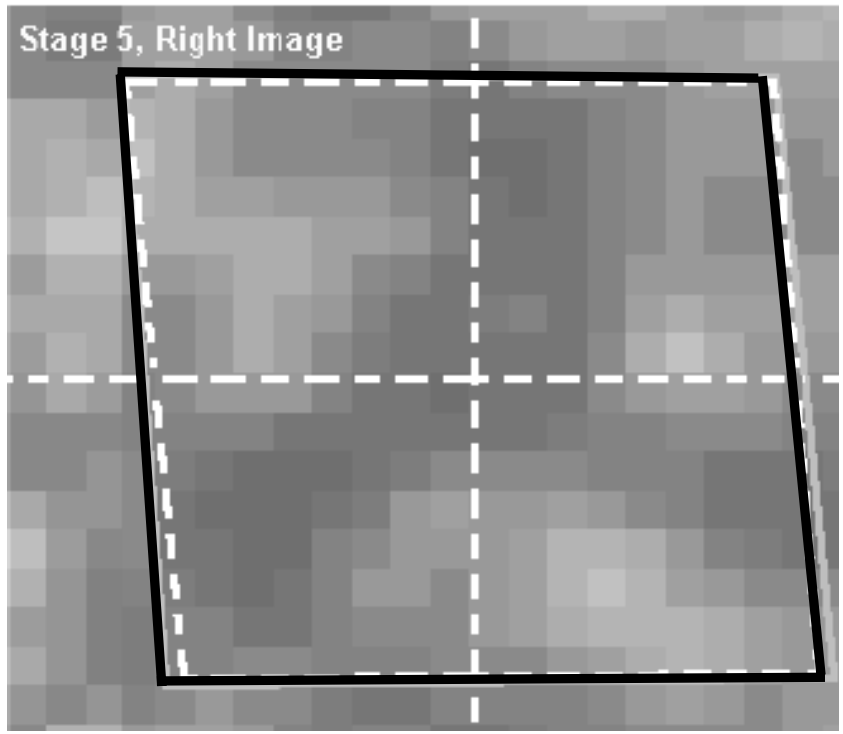




3-D Photogrammetry: General Measurement Process

- Coordinates assigned to facet corner and center by grayscale variation
- System tracks movement of facet center and corners

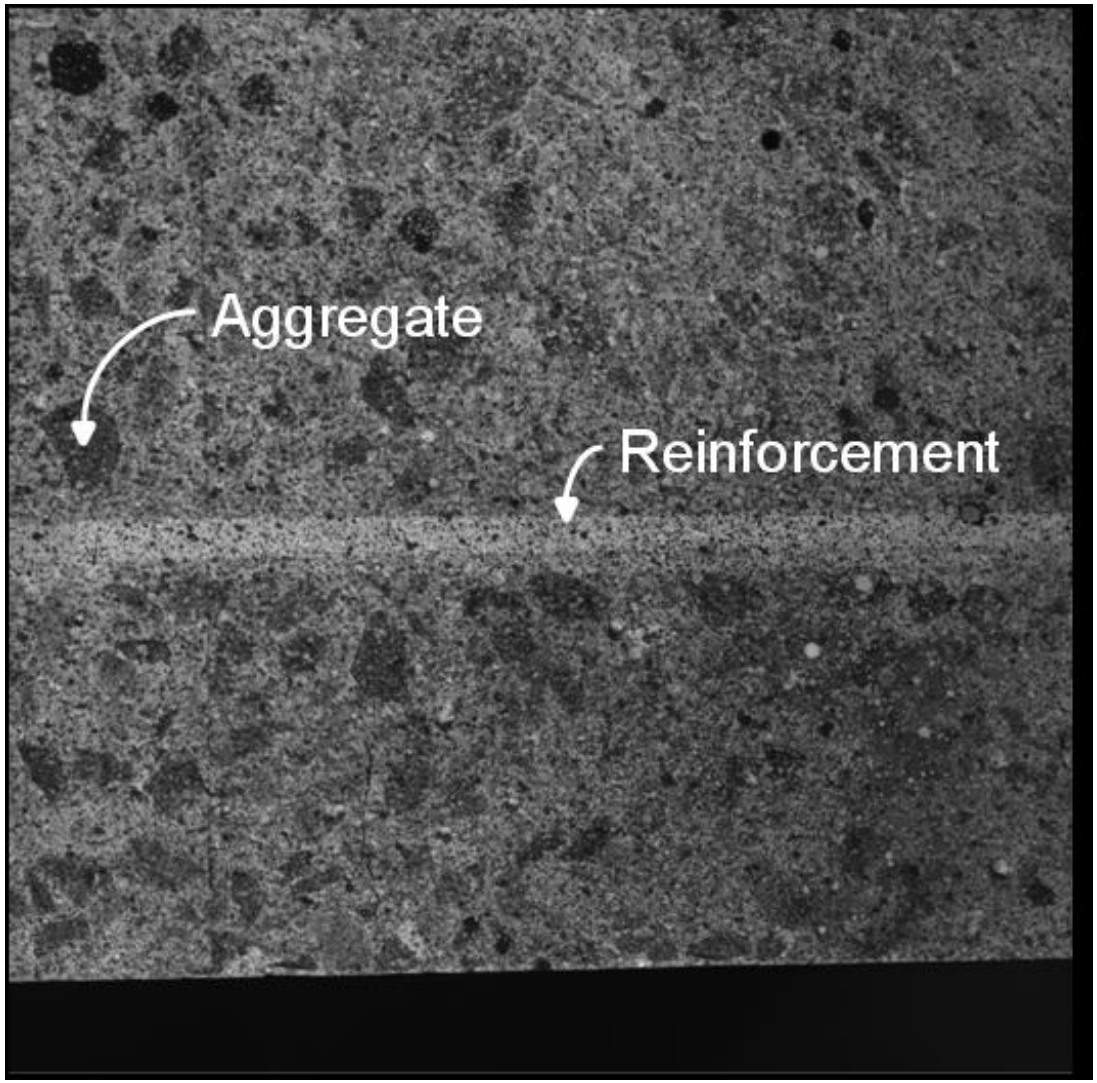




White line – original location
Black line – deformed shape

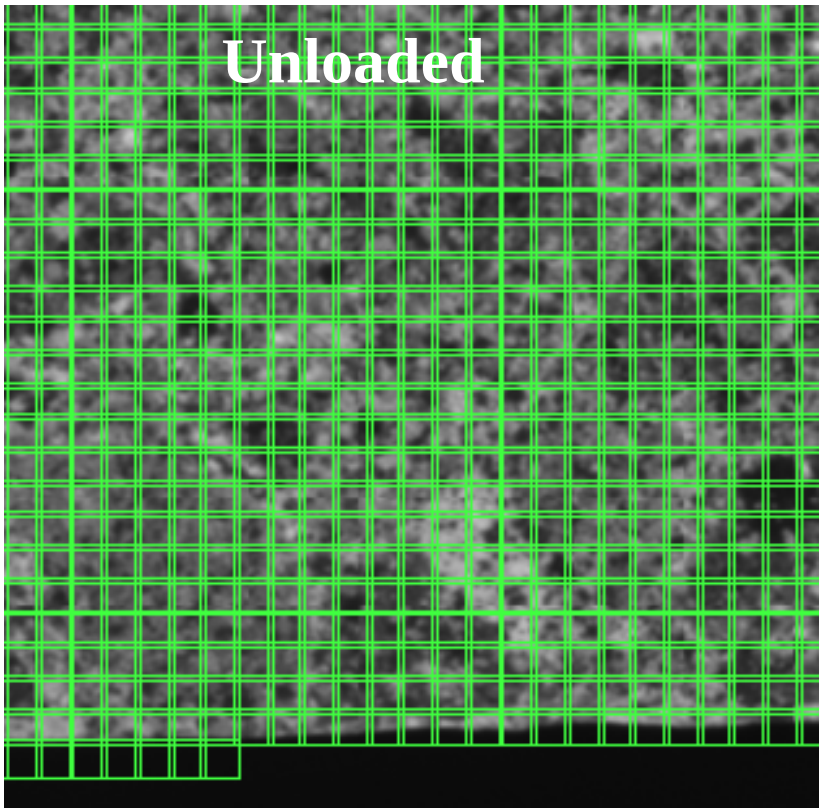
3-D Photogrammetry: Surface Preparation

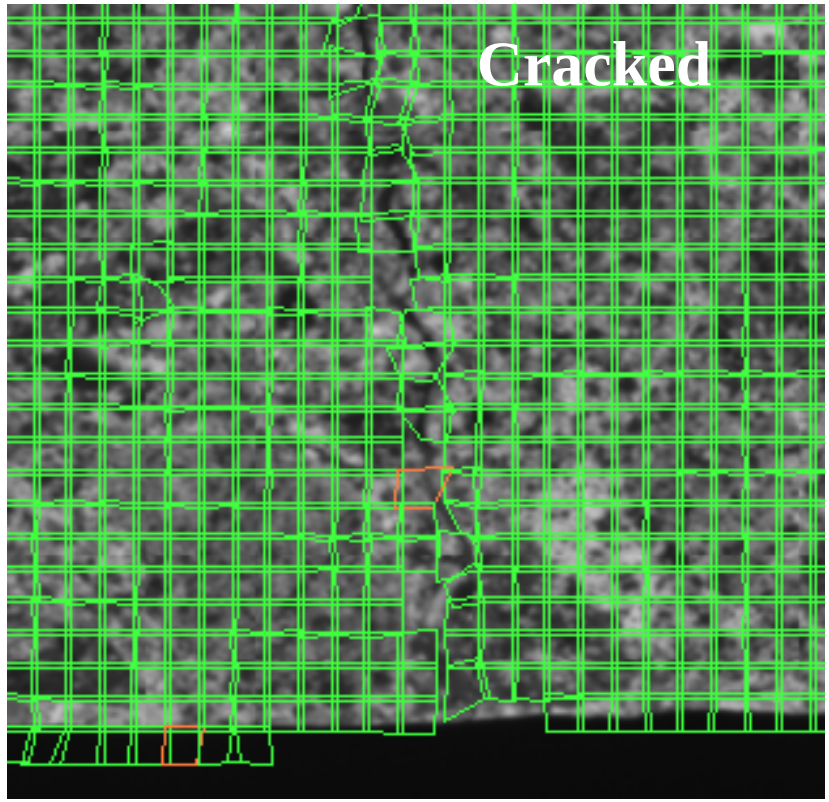
- Grayscale contrast obtained by speckle pattern



3-D Photogrammetry: Deformation Measurement

- Sample deformation measured as mesh movements





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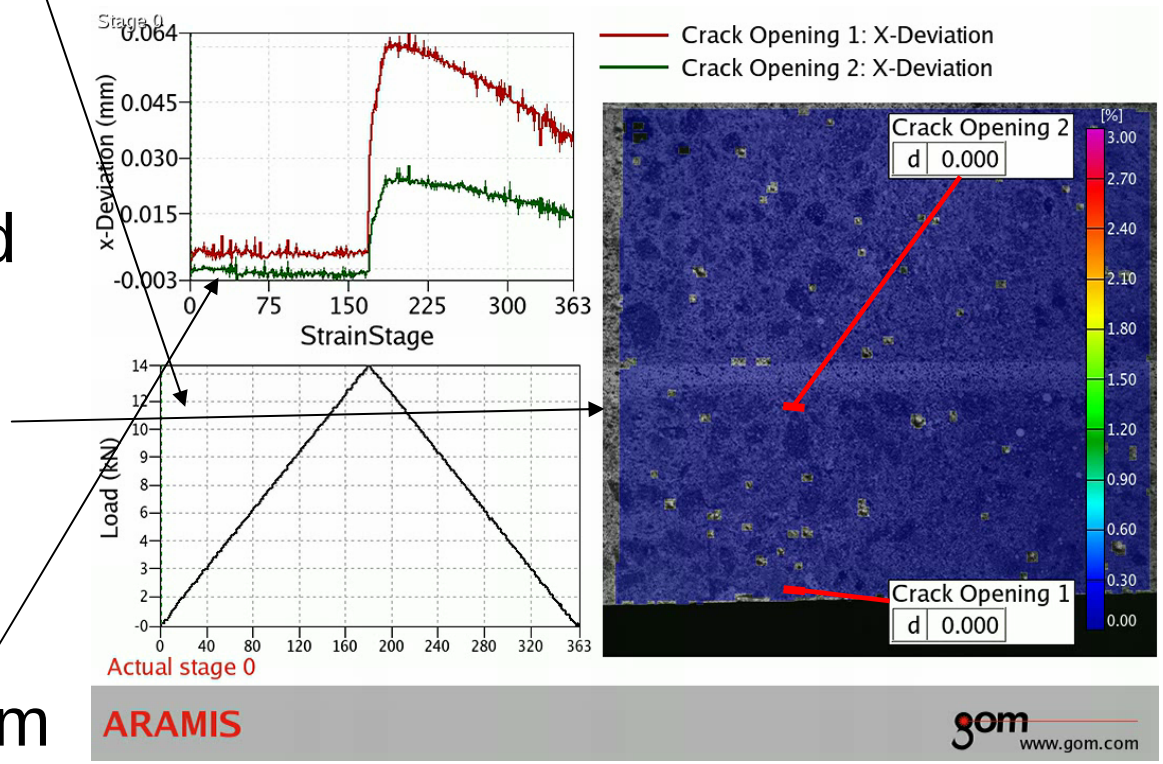
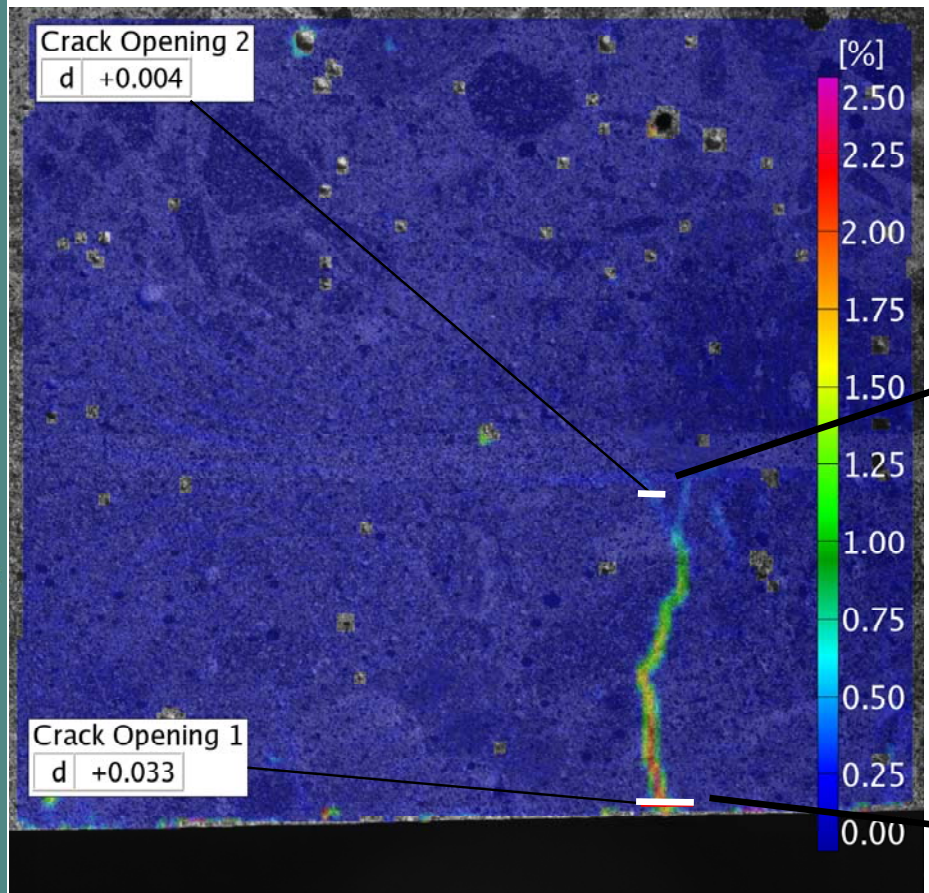
3-D Photogrammetry: Crack Geometry

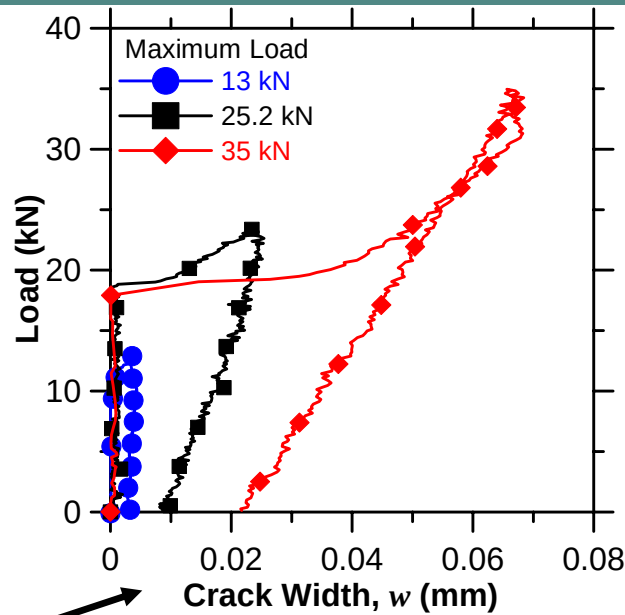
- All beams loaded at constant rate, maximum – 3 min. unloaded – 3 min.
- Video of measured deformation projected on beam surface
- Crack opening measurements from tension face and near reinforcement

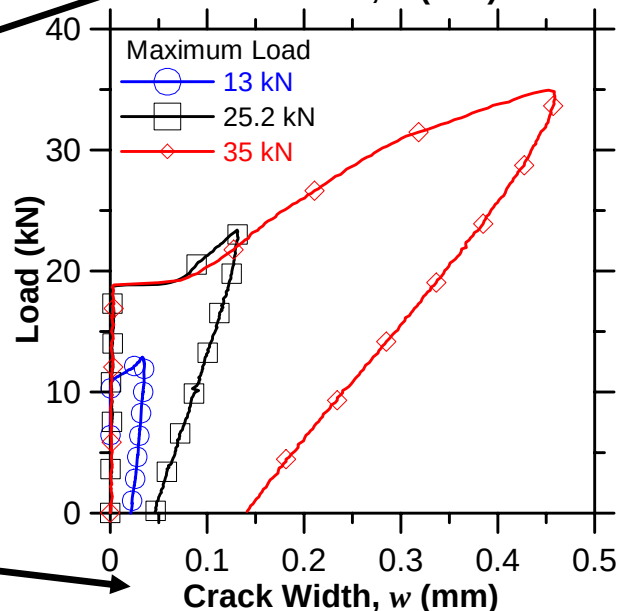


Crack Measurements: Crack Shape

- Load vs. crack width at various loadings from two locations
- V-Shaped crack

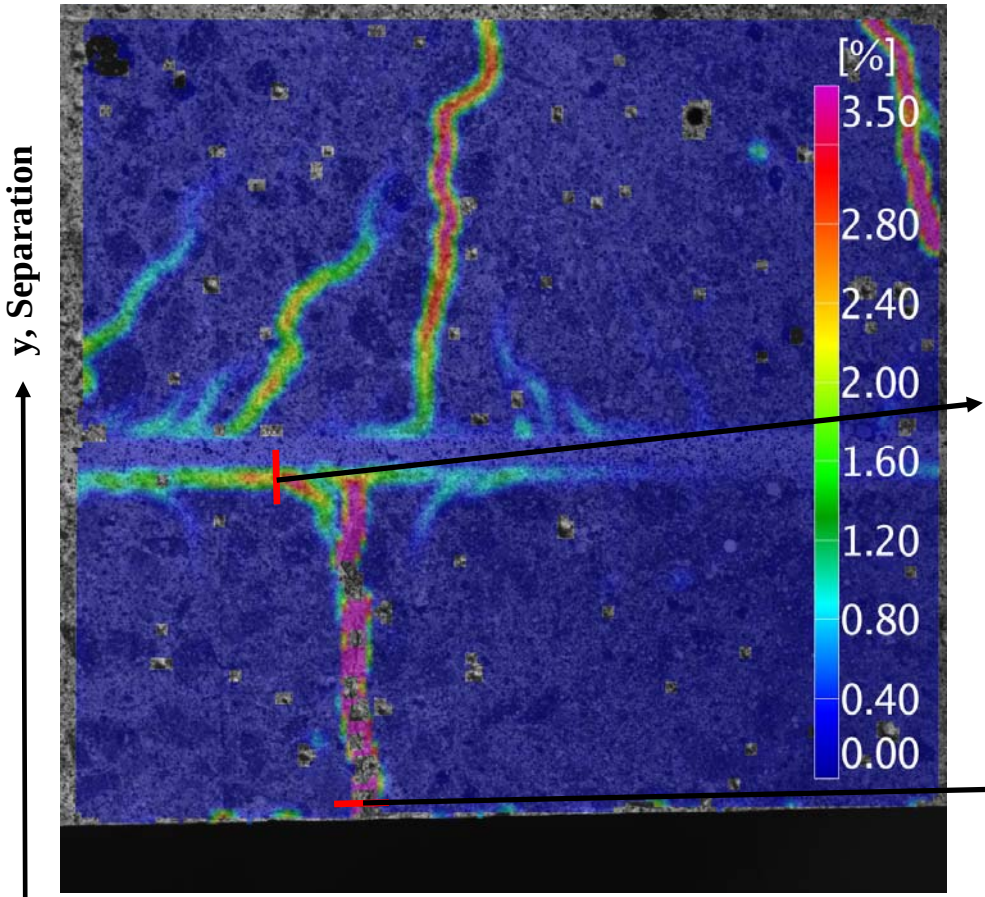


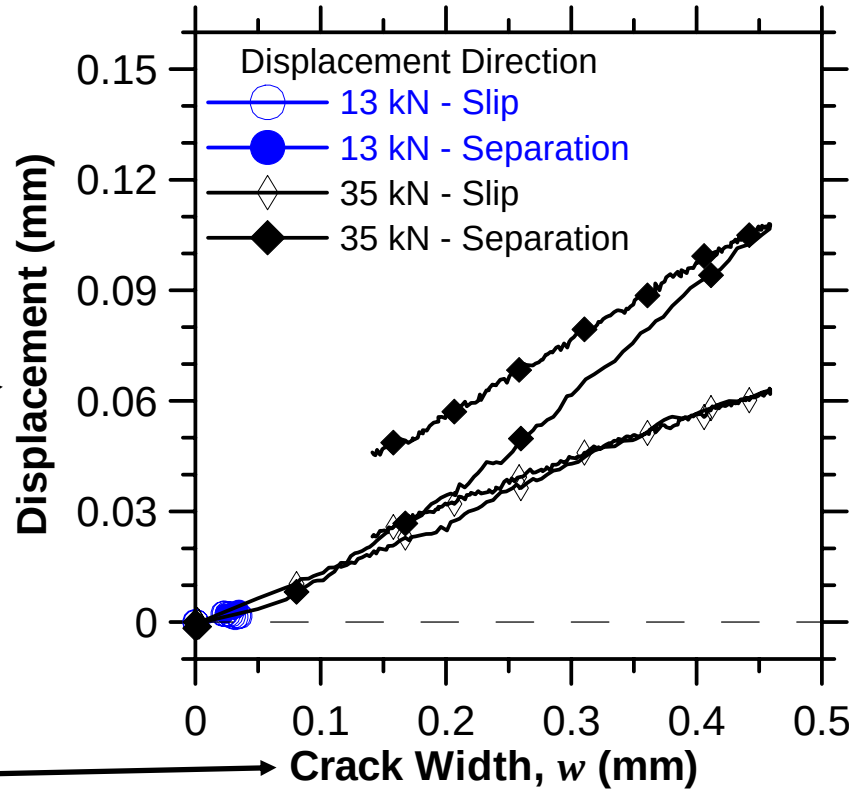




Crack Measurements: Slip and Separation

- Slip and separation vs. crack width near tensile face

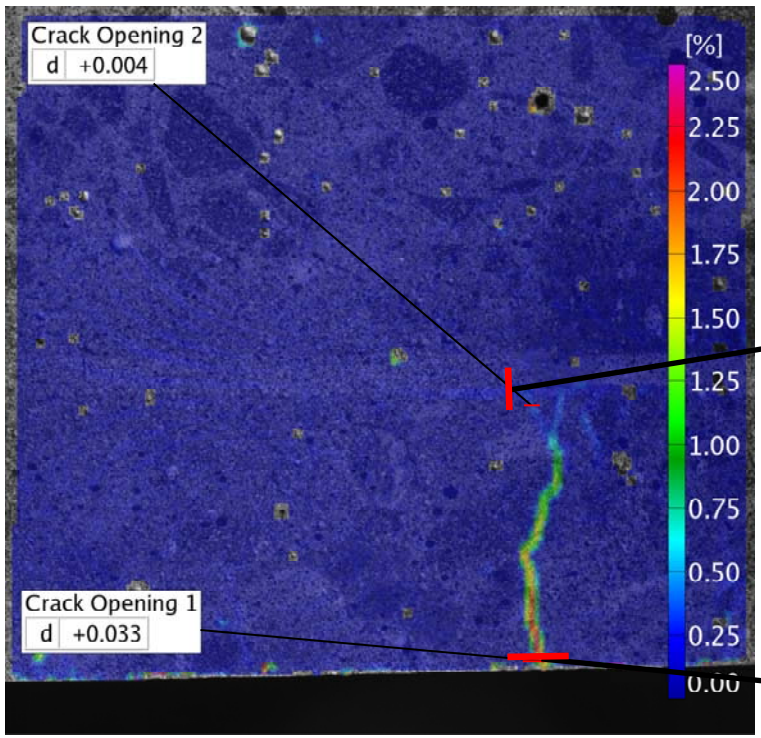


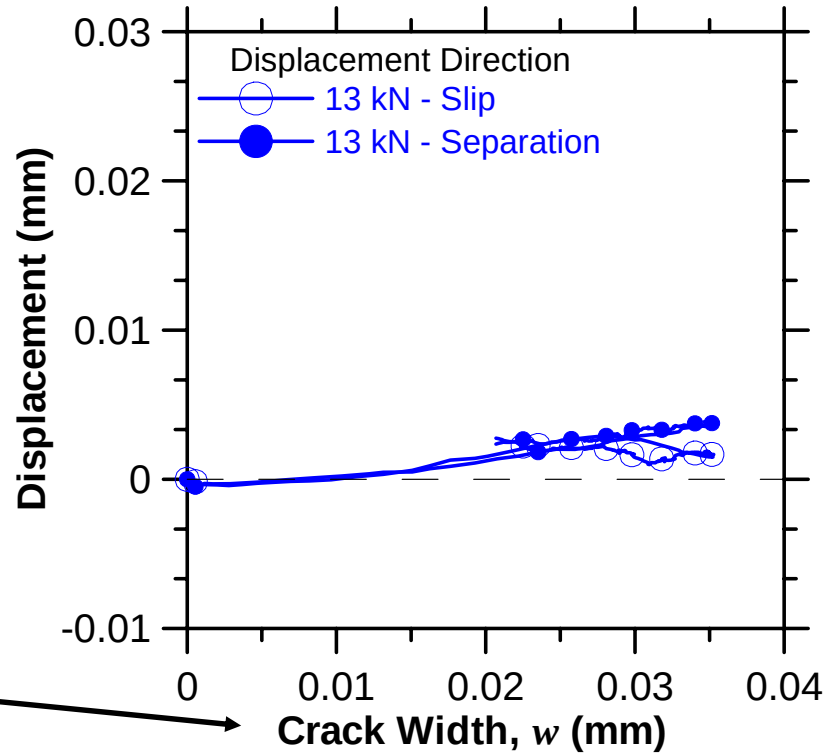


- Elastic slip response, inelastic separation

Crack Measurements: Slip and Separation

- Initiation of slip and separation
  - At estimated cracking load
    ~4 µm measured slip and separation
  - Measured deformations close to resolution, results inconclusive





Conclusions

- 3-D Photogrammetry used to quantify cracking under flexural loading
- Slip behavior between reinforcement and concrete is elastic while separation behavior is inelastic
- Slip and separation between reinforcement and concrete initiates after opening of crack at tensile face

Acknowledgements

Otto Mønsted
- FREMMER DANSK HANDEL OG INDUSTRI

Otto Mønsted Foundation – Travel Fund

The Velux Funds: Villam Kann Rasmussen Foundation – Funding for Aramis 3-D Photogrammetry Equipment